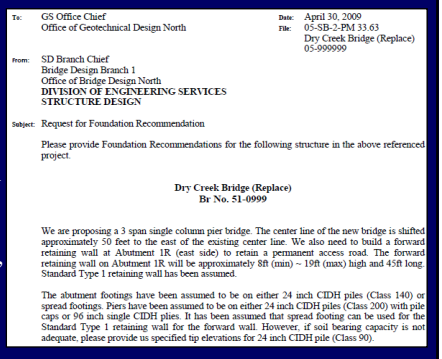
Preparation of the Foundation Report (FR)

To support the preparation of the Draft Structure Plans, Specifications and Estimate, SD provides the following data in a request for a Foundation Report:

- Scope of proposed work
- Location and site plans
- Utility plan
- Draft structure general plan
- Foundation plan showing support locations and elevations
- Approximate design structure loads at each support (FDDS per MTD 3-1 and 4-1)
- If needed, a request for soil-structure interaction analysis results, such as p-y, t-z, and q-z curves.
- Preliminary or Final Hydraulic Report
- Project schedule
  - Date final design loads will be available
  - Foundation Report due date



To: GS Office Chief
Office of Geotechnical Design North

Date: April 30, 2009
File: 05-SB-2-PM 33.63
Dry Creek Bridge (Replace)
05-999999

From: SD Branch Chief
Bridge Design Branch 1
Office of Bridge Design North
DIVISION OF ENGINEERING SERVICES
STRUCTURE DESIGN

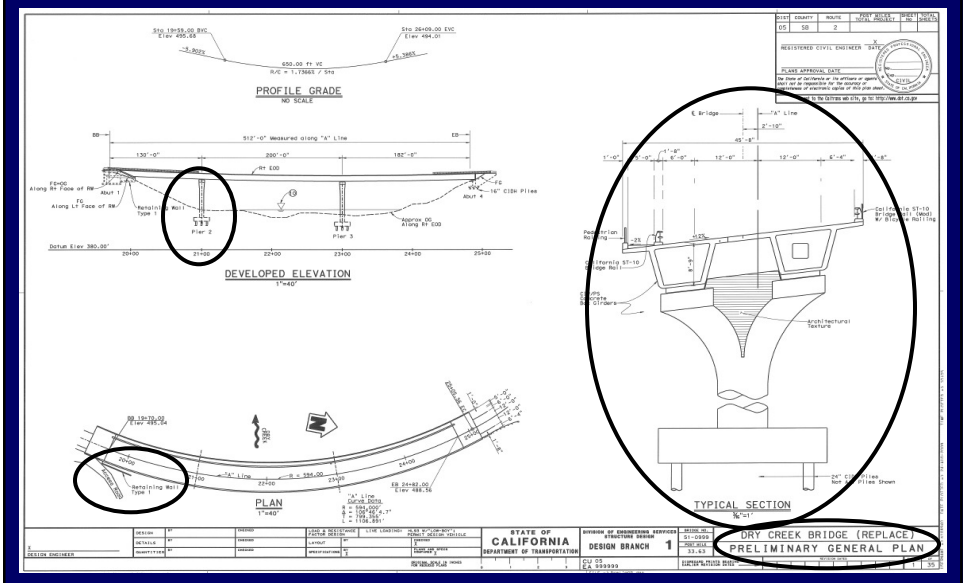
Subject: Request for Foundation Recommendation

Please provide Foundation Recommendations for the following structure in the above referenced project.

Dry Creek Bridge (Replace)
Br No. 51-0999

We are proposing a 3 span single column pier bridge. The center line of the new bridge is shifted approximately 50 feet to the east of the existing center line. We also need to build a forward retaining wall at Abutment 1R (east side) to retain a permanent access road. The forward retaining wall on Abutment 1R will be approximately 8ft (min) ~ 19ft (max) high and 45ft long. Standard Type 1 retaining wall has been assumed.

The abutment footings have been assumed to be on either 24 inch CIDH piles (Class 140) or spread footings. Piers have been assumed to be on either 24 inch CIDH piles (Class 200) with pile caps or 96 inch single CIDH plies. It has been assumed that spread footing can be used for the Standard Type 1 retaining wall for the forward wall. However, if soil bearing capacity is not adequate, please provide us specified tip elevations for 24 inch CIDH pile (Class 90).



Foundation Design Data Sheets

(unchecked loads)

Bridge Name: Dry Creek Bridge (Replace)

Br. No. 51-0999 EA: 05-999999 Date: 4-18-2009

Table 1. Shallow Foundation General Data

Foundation Design Data Sheet						
Support No.	Design Method	Finished Grade Elevation (ft)	BOF Elevation (ft)	Footing Size (ft)		Permissible Settlement under Service Load (in)
				B	L	
Abut 1	WSD	480.5	476.5	15	52.67	1
Abut 4	WSD	475.5	471.5	15	47.67	1

Table 2. Shallow Foundation Load Data

Foundation Design Loads							
Support No.	Total Load				Permanent Load*		
	Vertical Load (kip)	Effective Dimensions (ft)		Horizontal Load in Long. Direction (kip)	Vertical Load (kip)	Effective Dimensions (ft)	
		B'	L'			B'	L'
Abut 1	3245	13.7	52.67	N/A	2703	14.3	52.67
Abut 4	3225	13.8	47.67	N/A	2629	14.5	47.67

Used to compare the load demands (stress) to both the bearing resistance and the permissible contact stress.

Used to calculate both the nominal bearing resistance and the permissible contact stress for elastic settlement

Table 3. Deep Foundation General Information

Foundation Design Data Sheet								
Support No.	Design Method	Pile Type	Finished Grade Elevation (ft)	Cut-off Elevation (ft)	Pile Cap Size (ft)		Permissible Settlement under Service Load (in)	Number of Piles per Support
					B	L		
Abut 1	WSD	24" CIDH	480.5	476.75	9.0	52.67	1"	20
Pier 2 Alt. 1	LRFD	24" CIDH	483.5	466.25	28	39	1"	35
Pier 2 Alt. 2	LRFD	96" CIDH	483.5	472.0	N/A	N/A	1"	1
Pier 3 Alt. 1	LRFD	24" CIDH	482.0	466.25	28	39	1"	35
Pier 3 Alt. 2	LRFD	96" CIDH	482.0	472.0	N/A	N/A	1"	1
Abut 4	WSD	24" CIDH	475.5	471.75	9.0	47.67	1"	20

Table 4. Deep Foundation Load Data

Support	Foundation Design Loads: Strength Limit State (Controlling Group, kips)							Foundation Design Loads: Extreme Event Limit State (Controlling Group, kips)			
	Compression		Tension		Compression		Tension				
	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile			
Abut 1	2318	140	1776	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pier 2 Alt. 1	8533	N/A	6587	10624	400	0	0	6587	400	0	200
Pier 2 Alt. 2	6075	N/A				0	N/A	4129	N/A	0	N/A
Pier 3 Alt. 1	9824	N/A				0	0				
Pier 3 Alt. 2	6699	N/A	4750	8649	N/A	0	N/A				
Abut 4	2635	140	2039	N/A	N/A	N/A	N/A				

Used to calculate the pile design tip elevation for pile groups, to satisfy the factored comp. load

Used to calculate the pile design tip elevation controlled by elastic settlement

Used to calculate the pile design tip elevation for an individual pile, to satisfy the factored comp. load

Table 5. Scour Data

Support No.	Long Term Scour Elevation (Degradation and Contraction) (ft)	Short Term Scour Depth (Local) (ft)
Abut 1	n/a	n/a
Pier 2	477	5
Pier 3	477	5
Abut 4	n/a	n/a

Used for calculations with the Extreme Event Limit State Loads

Used for calculations with both the Service Limit State Loads and the Strength Limit State Loads

The focus of the Foundation Report is to provide foundation recommendations in a Pile Data Table or Spread Footing Data Table.

However, the FR is written for an audience that includes:

- Bidding contractors
- Structure design engineer
- Specifications engineer
- Construction engineer
- Attorneys!??

Pile Data Table

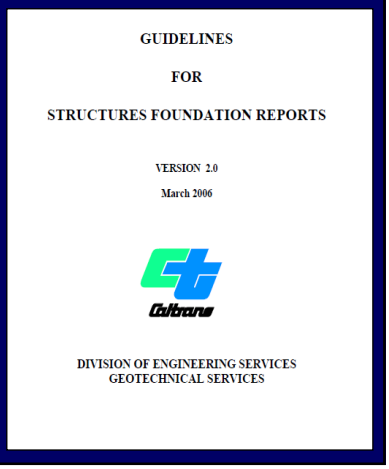
Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (ft)	Specified Tip Elevation (ft)
		Compression	Tension		
Pier 2	24 inch CIDH	580	200		
Pier 3	24 inch CIDH	580	200		
Abut. 4	16 inch CIDH	280	0		

Spread Footing Data Table

Support Location	Working Stress Design (WSD)		Load and Resistance Factor Design (LRFD)		
	Permissible Gross Contact Stress (Settlement) (ksf)	Allowable Gross Bearing Capacity (ksf)	**Service** Permissible Net Contact Stress (Settlement) (ksf)	**Strength** Factored Gross Nominal Bearing Resistance $\phi_b = X$ (ksf)	**Extreme Event** Factored Gross Nominal Bearing Resistance $\phi_b = 1.00$ (ksf)
Abut 1			N/A	N/A	N/A

The Foundation Report updates PFR information and includes design and construction recommendations based on site specific information.

- Project description and scope
- Existing facilities and proposed improvements
- Physical setting
- Geology and soil conditions
- Ground water conditions
- Laboratory Testing
- Seismicity
- Liquefaction
- Scour evaluation
- Corrosion evaluation
- Slope stability analyses
- Design analyses and recommendations*
- Construction considerations*
- Available project information
- LOTBs are "attached"



GUIDELINES

FOR

STRUCTURES FOUNDATION REPORTS

VERSION 2.0

March 2006

Caltrans

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

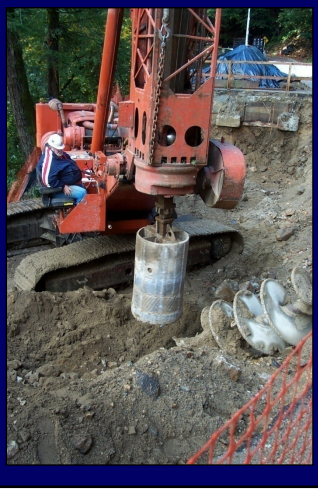
Contents of the design analyses and recommendations section

- Summary of geotechnical calculation methods used to develop the design recommendations
- The findings are presented in both the "Recommendations Tables" and the "Data Tables".
- Approach embankment settlement delay period
- Recommendations for the mitigation of downdrag forces on driven piles or drilled shafts
- Requirements for pre-drilling or pilot holes to facilitate the installation of driven pile foundations

The Geotechnical Design Report (GDR) provides recommendations such as embankment design, cut slope design and slope stabilization recommendations.

The construction considerations section provides information based on the borehole logs, laboratory tests and site observations:

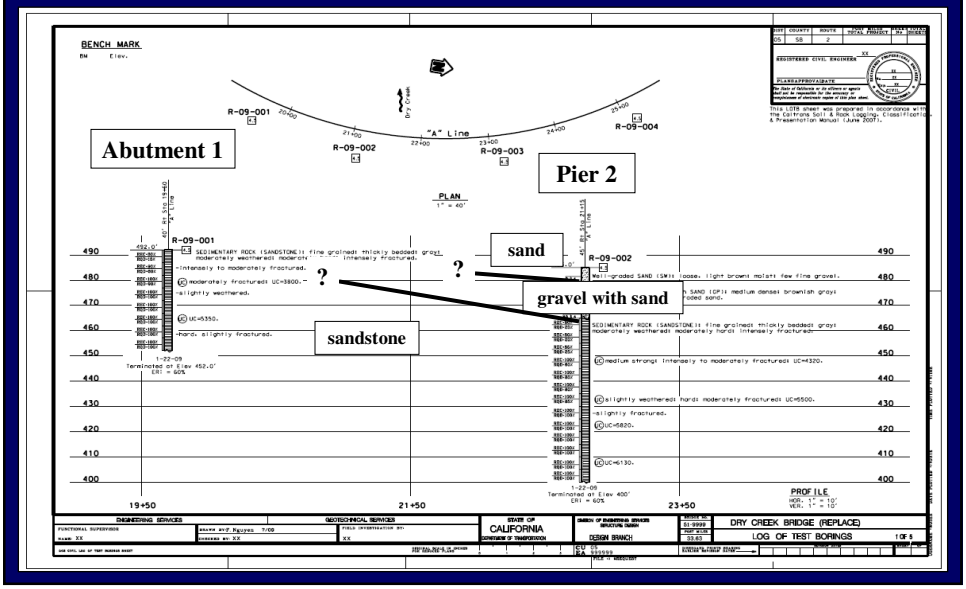
- Obstructions to pile driving
- Obstructions to shaft drilling
- Whether the caving of excavations is anticipated
- For potential bidders, highlight the existence of variable subsurface conditions that may affect construction methods and production rates.



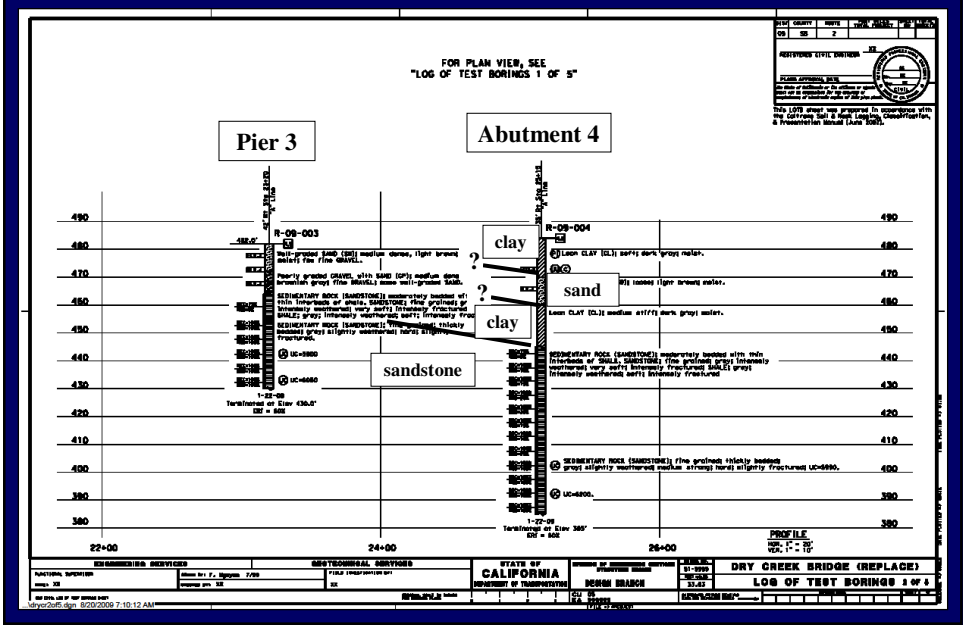
Typical steps for developing the foundation recommendations

1. Confirm the proposed foundation design types and loads with the designer:
   - Abutment 1 and Abutment 4
     - Spread footing, or
     - A group of 24 inch diameter drilled shafts
   - Pier 2 and Pier 3
     - A group of 24 inch diameter drilled shafts, or
     - One 96 inch diameter drilled shaft
2. Produce subsurface models for all of the bridge support locations
3. Analyze settlement of the foundation soils at the bridge support locations in response to the placement of new fill
4. Analyze the stability of existing and proposed natural and constructed slopes adjacent to the bridge foundations
5. Consider the constructability of the proposed foundation configurations
6. Perform geotechnical analyses of the proposed shallow foundations
7. Perform geotechnical analyses of the proposed deep foundations
8. Write the Foundation Report

Produce a subsurface model for each important location

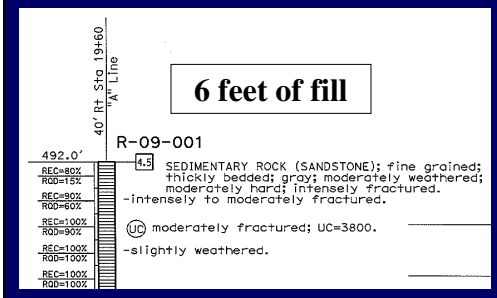


Produce a subsurface model for each important location



Evaluate the approach embankment settlement at the abutments

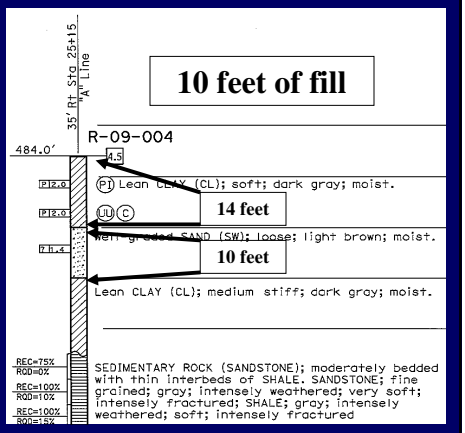
Abutment 1



Elastic settlement = 0.0 inches

Consolidation settlement = 0.0 in.

Abutment 4



Elastic settlement = 0.3 inches

Consolidation settlement = 1.1 in.

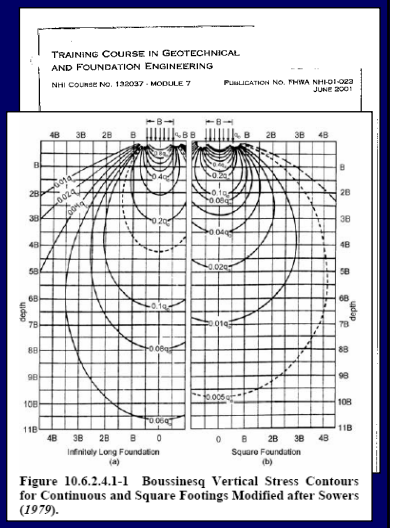
Consider movement of the adjacent slopes that can impact the structure foundations

Abutment 1

Abutment 4

Shallow foundations design analyses procedures (LRFD)

1. Nominal bearing resistance
   1. Calculate the nominal bearing resistance using the effective footing dimensions provided.
   2. Compare to the factored nominal bearing resistance to the bearing pressure applied by the structure.
2. Permissible contact stress
   1. Determine the magnitude of pressure that when applied to the effective footing dimensions will result in the "limiting magnitude of tolerable foundation settlement".
   2. Compare the permissible contact stress to the Service Limit State bearing stress.


TRAINING COURSE IN GEOTECHNICAL AND FOUNDATION ENGINEERING

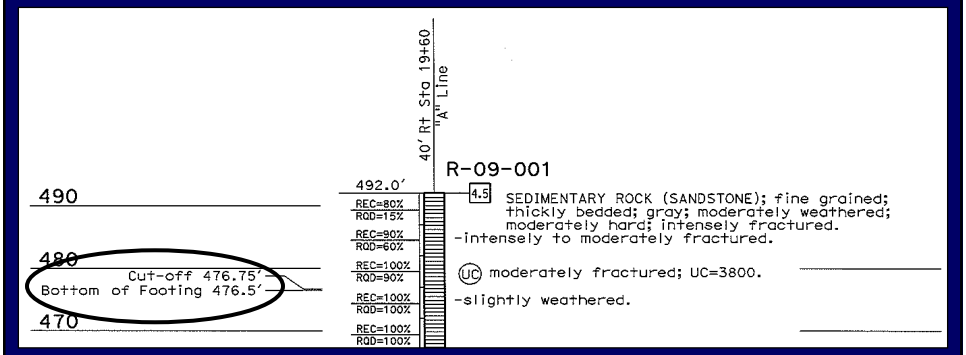
NHI COURSE NO. 132037 - MODULE 7 PUBLICATION NO. FHWA NHI-01-023 JUNE 2001

Infinitely Long Foundation (a) Square Foundation (b)

Figure 10.6.2.4.1-1 Boussinesq Vertical Stress Contours for Continuous and Square Footings Modified after Sowers (*1979*).

Dry Creek Bridge foundation design

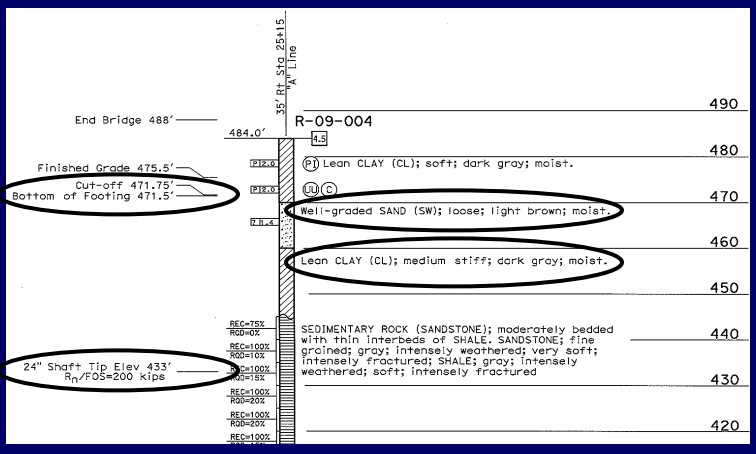
Abutment 1 and Retaining wall 1R foundation alternatives are spread footings and 24 inch drilled shafts



- The proposed bottom of footing for Abutment 1 and Retaining wall 1R will be in moderately hard, slightly weathered sandstone.
- The sandstone has sufficient rock mass strength to provide a bearing resistance with applied safety factor that exceeds the applied factored bearing pressure.
- The sandstone has very low compressibility, therefore the permissible contact stress exceeds the applied factored bearing stress.

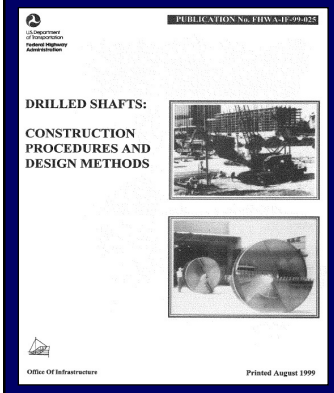
Dry Creek Bridge foundation design

Abutment 4 foundation alternatives are a spread footing and 24 inch drilled shafts



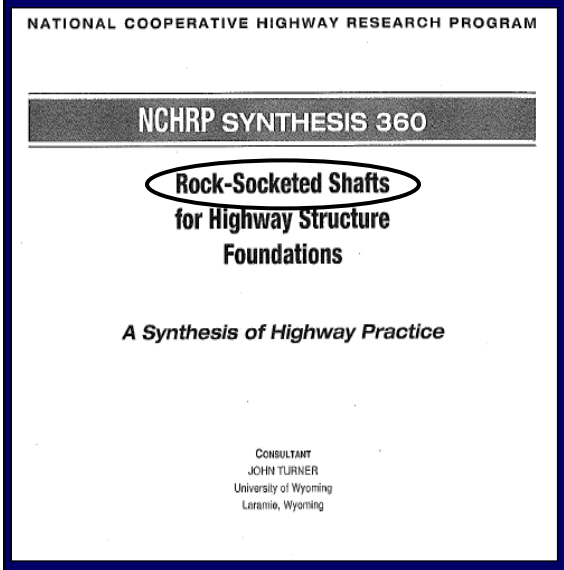
- Abutment 4 will be founded on an engineered fill overlying soft and medium stiff lean clay, and loose sand. Sandstone was encountered at elevation 453.
- There is no scour anticipated at Abutment 4.
- The 24 inch diameter drilled shafts will have specified tip elevations of 433 feet.
- The 24 inch diameter drilled shafts will be installed with the plastic pipes that are necessary for the concrete testing needed for a “wet” pour.

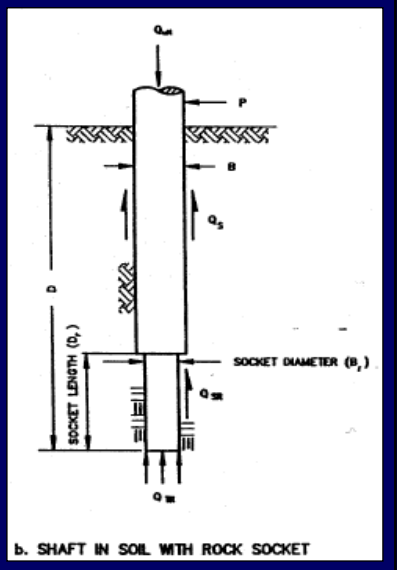
Deep foundation design analyses



- A bridge support location may require calculations for all of the following design tip elevations:
  1. Strength Limit State compression per pile
  2. Strength Limit State compression for the pile group
  3. Extreme Event Limit State compression per pile
  4. Extreme Event Limit State compression for the pile group
  5. Strength Limit State tension per pile
  6. Strength Limit State tension for the pile group
  7. Extreme Event Limit State tension per pile
  8. Extreme Event Limit State tension for the pile group
- Additionally, it is necessary to calculate the design tip elevation for the permissible settlement threshold when the Service Limit State Load is applied:
  - For the group of piles, or
  - Per pile
- The specified tip elevation is the lowest of as many as these 9 calculated design tip elevations.

Analyses of drilled shafts that penetrate rock





Design tip analyses for compression and tension load demands

Drilled shaft group analyses

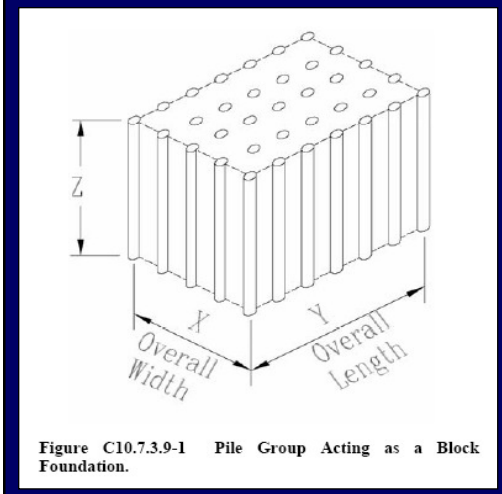
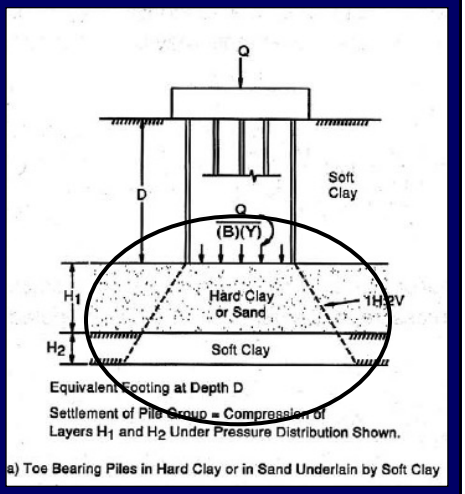


Figure C10.7.3.9-1 Pile Group Acting as a Block Foundation.

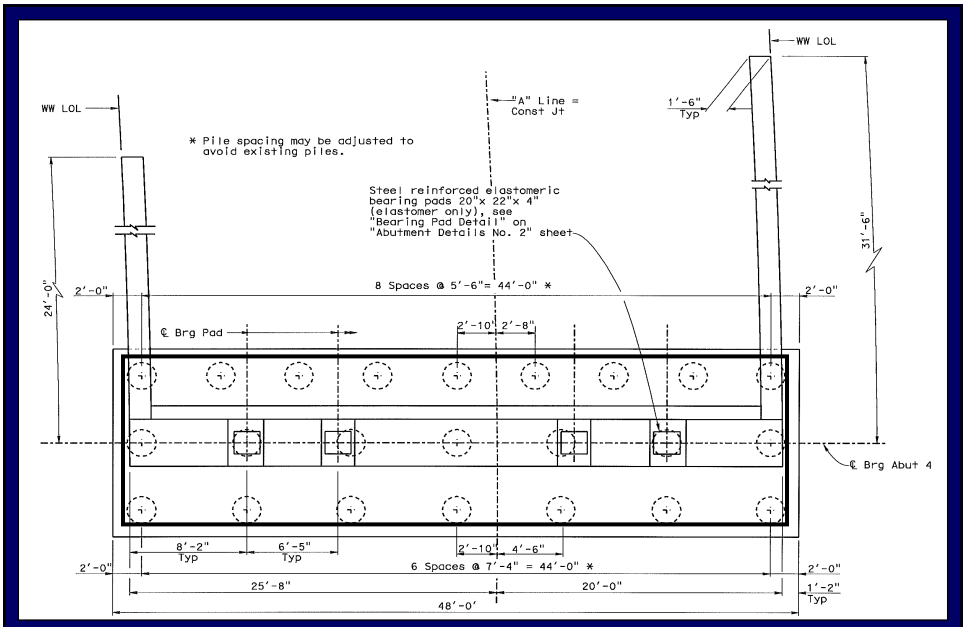
Nominal resistance calculation

"Equivalent Pier"



Pile group settlement calculation

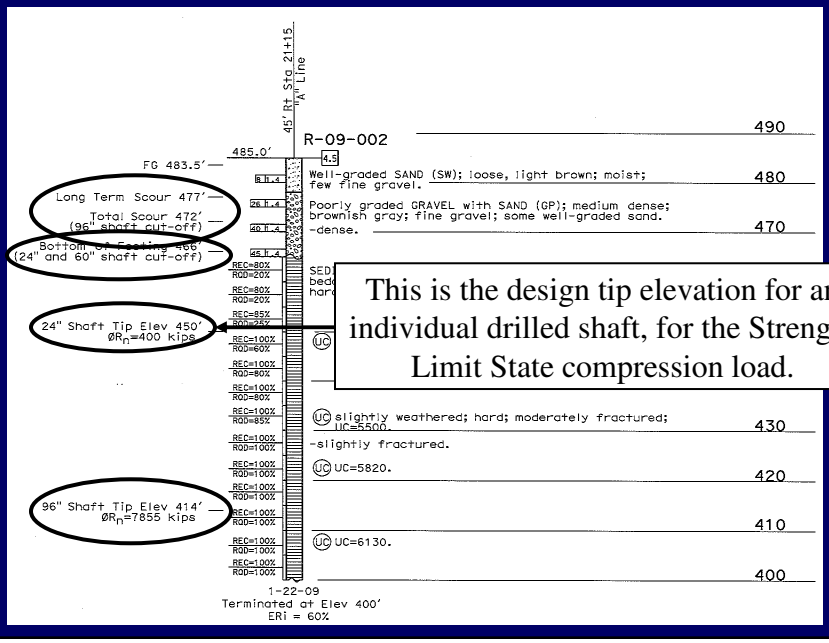
"Equivalent Footing"



Abutment 4 drilled shaft layout is used for the pile group analyses.

Dry Creek Bridge foundation design

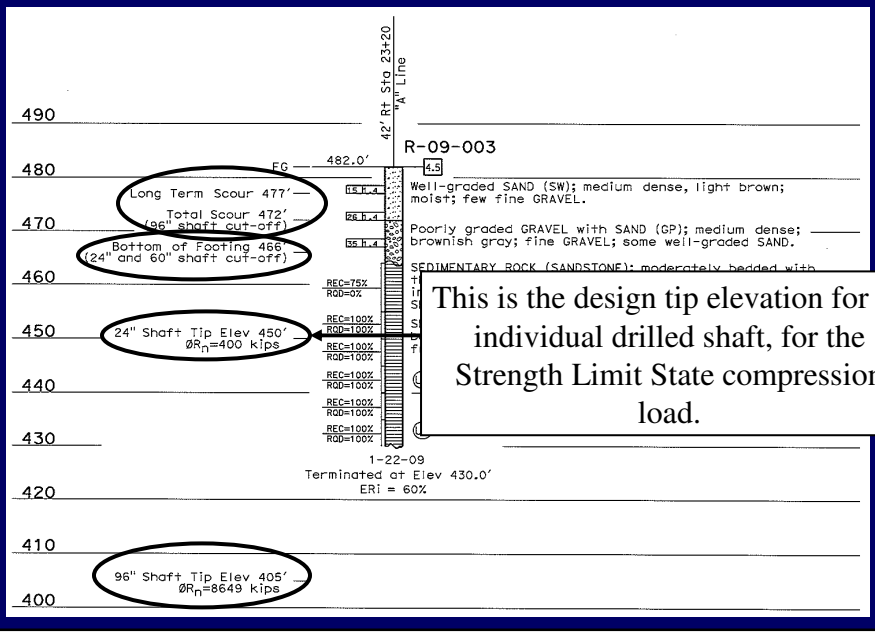
Pier 2 foundation alternatives are a group of 24 inch CIDH piles and one 96 inch diameter drilled shaft



This is the design tip elevation for an individual drilled shaft, for the Strength Limit State compression load.

Dry Creek Bridge foundation design

Pier 3 foundation alternatives are a group of 24 inch CIDH piles and one 96 inch diameter drilled shaft



This is the design tip elevation for an individual drilled shaft, for the Strength Limit State compression load.

Draft Foundation Report provides foundation data tables

Spread Footing Data Table

Support Location	Working Stress Design (WSD)		Load and Resistance Factor Design (LRFD)		
	Permissible Gross Contact Stress (Settlement) (ksf)	Allowable Gross Bearing Capacity (ksf)	**Service** Requisible Net Contact Stress (Settlement) (ksf)	**Strength** Factored Gross Nominal Bearing Resistance $\phi_b = X$ (ksf)	**Extreme Event** Factored Gross Nominal Bearing Resistance $\phi_b = 1.00$ (ksf)
Abut 1	12	10	N/A	N/A	N/A

Pile Data Table

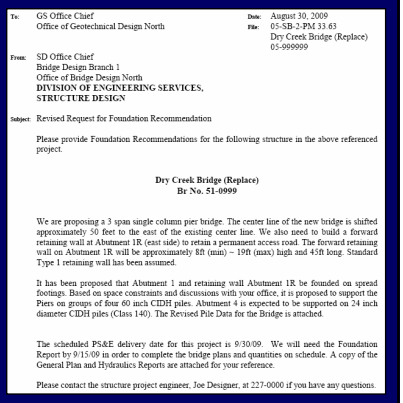
Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (ft)	Specified Tip Elevation (ft)
		Compression	Tension		
Pier 2	24 inch CIDH	580	200	450 (a) 458 (b) 460 (c)	450
Pier 3	24 inch CIDH	580	200	450 (a) 458 (b) 460 (c)	450
Abut. 4	24 inch CIDH	400	0	433 (a) 443 (c)	433

Notes:

1) *Design tip elevations for the Abutment is controlled by: (a) Compression, (c) Settlement, (d) Lateral Load*
2) *Design tip elevations for Bents are controlled by: (a) Compression, (b) Tension, (c) Settlement (d) Lateral Load*
3) *The specified tip elevation shall not be raised.*

Revised Foundation Report request

- Revised general plan
- Revised FDDS provides
  - Piers 2 and 3 will be supported on groups of five 60 inch diameter drilled shafts
  - Revised foundation load demands
- Pier and abutment detail plan sheets



To: GS Office Chief
Office of Geotechnical Design North

Date: August 30, 2009
File: 05-SB-2-PM 33.63
Dry Creek Bridge (Replace)
05-999999

From: SD Office Chief
Bridge Design Branch 1
Office of Bridge Design North
DIVISION OF ENGINEERING SERVICES,
STRUCTURE DESIGN

Subject: Revised Request for Foundation Recommendation

Please provide Foundation Recommendations for the following structure in the above referenced project.

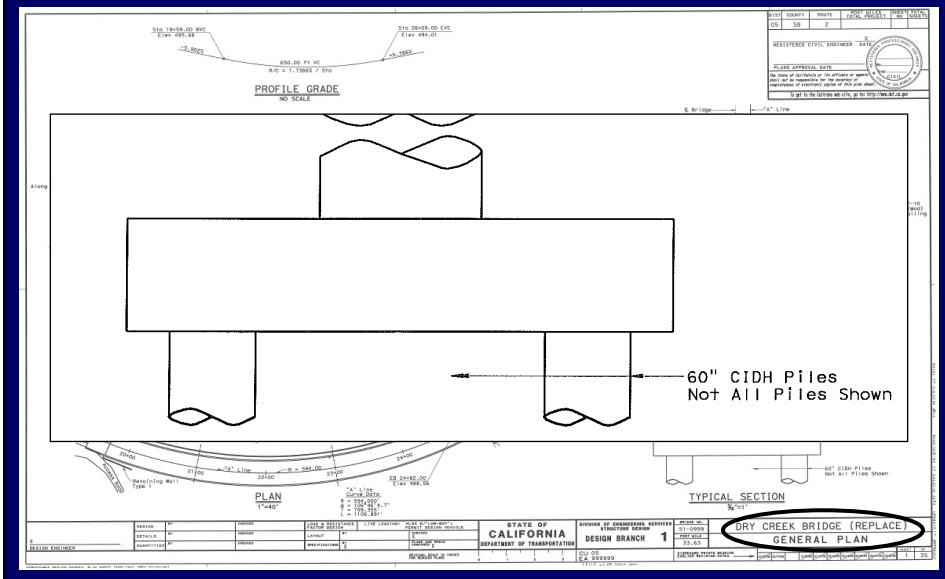
Dry Creek Bridge (Replace)
Br No. 51-0999

We are proposing a 3 span single column pier bridge. The center line of the new bridge is shifted approximately 50 feet to the east of the existing center line. We also need to build a forward retaining wall at Abutment 1R (east side) to retain a permanent access road. The forward retaining wall on Abutment 1R will be approximately 8ft (min) – 19ft (max) high and 45ft long. Standard Type 1 retaining wall has been assumed.

It has been proposed that Abutment 1 and retaining wall Abutment 1R be founded on spread footings. Based on space constraints and discussions with your office, it is proposed to support the Piers on groups of four 60 inch CIDH piles. Abutment 4 is expected to be supported on 24 inch diameter CIDH piles (Class 140). The Revised Pile Data for the Bridge is attached.

The scheduled PS&E delivery date for this project is 9/30/09. We will need the Foundation Report by 9/15/09 in order to complete the bridge plans and quantities on schedule. A copy of the General Plan and Hydraulics Reports are attached for your reference.

Please contact the structure project engineer, Joe Designer, at 227-0000 if you have any questions.



Foundation Design Data Sheet
for Deep Foundations *(unchecked loads)*
Bridge Name: Dry Creek Bridge (Replace)
Br. No. 51-0999 EA: 05-999999 Date: **8-30-2009**

Table 1. Deep Foundation Data

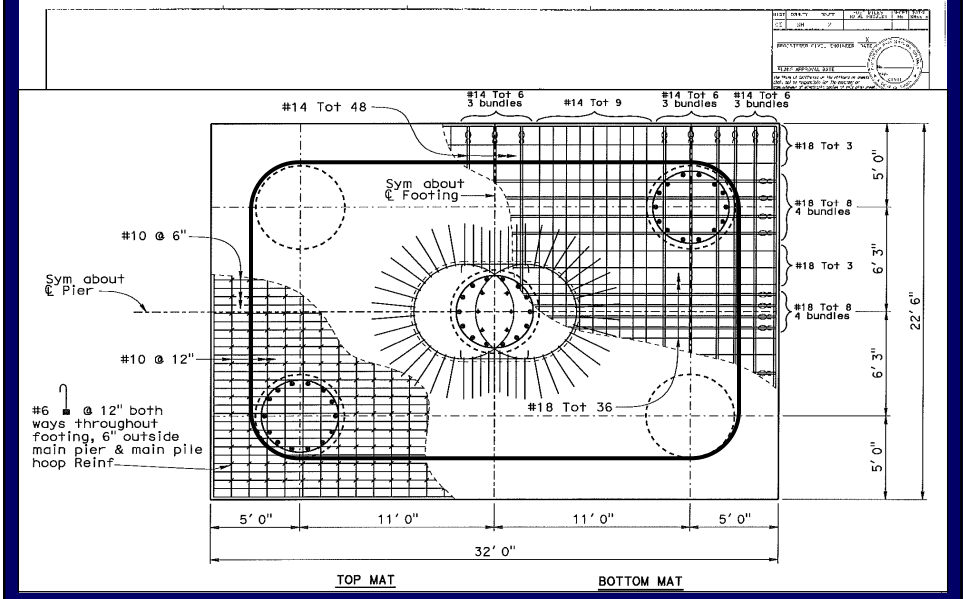
Support No.	Design Method	Pile Type	Finish Grade Elevation (ft)	Cut-off Elevation (ft)	Pile Cap Size (ft)		Permissible Movement under Service Load (inch)		Number of Piles per Support
					B	L	Δ_V	Δ_H	
Pier 2	LRFD	60" CIDH	483.5	466.25	28.5	32	1	0.25	5
Pier 3	LRFD	60" CIDH	482.0	466.25	22.5	32	1	0.25	5

Table 2. LRFD Service Limit State I Load Data*

Support No.	Total Vertical Load (kips)		Permanent Load Per Support (kips)
	Per Support	Max. Per Pile	
Pier 2	8533	1833	6587
Pier 3	9824	1833	7875

Table 3. LRFD Strength and Extreme Event Limit State Load Data*

Support No.	Strength Limit State (Group II) (kips)				Extreme Event Limit State (Group I) (kips)			
	Compression		Tension		Compression		Tension	
	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Pier 2	10624	2300	0	n/a	4129	3430	0	n/a
Pier 3	12101	2300	0	n/a	4750	3430	0	n/a



Pier 2 and 3 drilled shaft layout for the analysis of the nominal resistance and settlement of the drilled shaft group.

Completed revised pile data table

Pile Data Table

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (ft)	Specified Tip Elevation (ft)
		Compression	Tension		
Pier 2	60 inch CIDH	3430	0	433 (a) 460 (c)	433
Pier 2	24 inch CIDH	580	200	450 (a) 458 (b) 460 (c)	450
				443 (c)	

Notes:

1) *Design tip elevations for the Abutment is controlled by: (a) Compression, (c) Settlement, (d) Lateral Load*
2) *Design tip elevations for Bents are controlled by: (a) Compression, (c) Settlement, (d) Lateral Load*
3) *The specified tip elevation shall not be raised.*

Questions?